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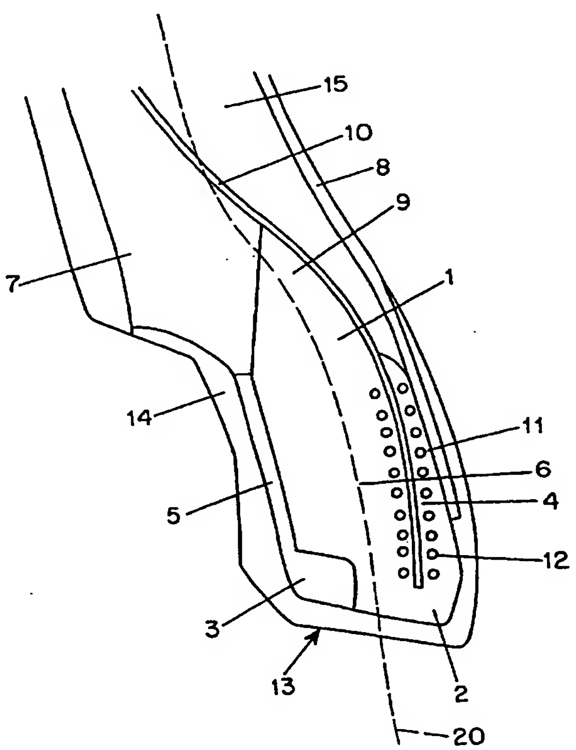
(54) Title: TIRE BEAD WITH SOFT HEEL



(57) Abstract: The invention provides a tire comprising at least one carcass structure (10) anchored in each side of the tire in a bead, the bead having a base which is intended to be mounted on the tire's design mounting rim, each bead being extended radially upward by a sidewall portion, the sidewall portions joining a tread portion, wherein said bead further comprises an anchoring zone (4) for anchoring said carcass in said bead and a heel portion (3) provided with elastomeric filler having a modulus of elasticity substantially lower than the anchoring zone (4) elastomeric filler modulus.

WO 02/30690 A1

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TIRE BEAD WITH SOFT HEEL

BACKGROUND OF THE INVENTION

The invention relates to a tire, more specifically to a pneumatic tire capable of continued mobility in a deflated condition.

Various tire constructions have been proposed for pneumatic runflat tires; that is tires, which normally operate in an inflated condition but which also permit a limited operation in a deflated condition. These tires constructions are generally formed of one or more generally radial carcasses which are turned up around one or more bead wires arranged in each bead. To obtain the desired mobility in the deflated condition, many of these tires further employ sidewalls which are reinforced and thickened by interposing additional rubber layers between the carcasses or between the carcasses and the tire inner liner.

It is also important to provide proper bead retention, so that the runflat tire remains seated on the rim during deflated operation.

Many solutions have been proposed including mechanical bead locks, special rim profiles or bead wire bundles of elongated cross-section. The elongated bead wire bundle functions both to anchor the carcass in the bead to resist tensile forces developed in the carcass and to retain the bead on the rim seat during deflated operation. This dual function necessitates design compromises.

Inflated and deflated performance also depends on the carcass structural arrangement, materials and on the carcass path. In known runflat tires, the carcass path is such that, in operation, at least a portion of the carcass may be placed in a compressive stress due to its position at the axially outward side of the bead/sidewall structure. Tensile-compressive cyclic stress may affect the product durability. For instance tires having carcasses turned up around bead wires necessarily have a discontinuity at the radially uppermost extent of the turned up portion of one or more of the carcasses. When the turned up portion is axially

positioned to the exterior of a median axis of the tire cross section, deformation of the bead portion due to loading the tire places the turned up portion in a state of compressive stress. This stress state and the aforementioned discontinuity lead to design constraints resulting in tire performance compromises between the inflated and deflated states.

BRIEF SUMMARY OF THE INVENTION

The invention provides a tire comprising at least one carcass structure anchored in each side of the tire in a bead, each bead having a base which is intended to be mounted on the tire's design mounting rim, each bead being extended radially upward by a sidewall portion, a reinforced summit, the sidewall portions joining said summit, wherein said bead further comprises an anchoring zone for anchoring said carcass in said bead and a heel portion provided with elastomeric filler having a modulus of elasticity substantially lower than the anchoring zone elastomeric filler modulus.

Such a heel portion, with a lower modulus, provides a lower seating pressure. The "fulcrum" effect, which provides a tendency for unseating of the bead, is reduced. Comfort and mountability are also improved. A potential reduction in steel mass in the bead region may provide a reduced mass. Advantageously, the heel portion has a Shore A hardness of about 55 to 65, and a modulus at 10 % of 2 to 6 MPa. A "modulus at 10 %" of an elastomeric filler means a secant extension modulus obtained at an uniaxial extension deformation of the order of 10 % at ambient temperature.

The heel portion is preferably disposed in the axially substantially outermost portion of the bead, advantageously in the radially substantially innermost portion of the bead.

Preferably, the heel portion extends axially inward, advantageously up to a position substantially adjacent to the median reference profile of the bead.

Preferably, at least a section of said heel portion extends substantially radially outward, advantageously up to the radially outermost portion of the mounting surface side of the bead.

This extending portion provides a soft zone or decoupling zone enhancing comfort. The "fulcrum" effect is reduced, minimizing the risks for unseating.

Preferably, the bead further comprises a toe portion provided with elastomeric filler having a modulus of elasticity substantially the same or higher than the anchoring zone elastomeric filler modulus. The toe portion is advantageously disposed axially and radially inward with respect to the anchoring zone.

Such a toe portion provides emphasized placement in the toe region. The simultaneous use of the toe and heel portions contributes to increase the gap between the mechanical effects provided by each one of said heel and said toe with respect to the placement of the bead. The very hard elastomeric mix, for instance up to or even greater than 60 MPa improves deflated bead retention, for instance in preventing unseating of toe region during deflated operation cornering.

Preferably, the bead further comprises a carcass cooperating element provided radially outward of the bead and axially outward of the carcass structure. The carcass cooperating element is advantageously provided with a substantially curvilinear profile adapted to cooperate with the carcass structure from the top of the anchoring zone towards a radially and axially outermost zone of the sidewall.

Depending on the operating conditions, the carcass cooperating element may provide a support, a guide or an orientation zone for the carcass structure. Optimal carcass path may be better provided with such a cooperating element or surface. For instance, it may advantageously be provided to guide or orient the carcass in accordance with a path having minimum probabilities to be under a compressive stress during operation both in inflated and in deflated conditions .

Preferably, the anchoring zone is provided with at least one first bead reinforcement, axially bordering said carcass structure, for anchoring said at least one carcass structure in the beads. The bead reinforcement advantageously includes substantially circumferentially oriented cords laterally bordering the carcass structure on at least one side and taking up the tension developed in the carcass during inflated or deflated use of the tire.

The tire also preferably comprises a second bead reinforcement, for instance axially outwardly spaced apart from said first bead reinforcement. This second bead reinforcement advantageously includes substantially circumferentially oriented cords. Such a dual arrangement with two spaced apart bead reinforcements provides an increase in bending and torsional rigidity. This is advantageous, in particular for heavier vehicles with taller sidewall tires.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates the lower sidewall and bead portion of a runflat tire according to the invention, taken along a meridian plane through the axis of rotation;

Figure 2 illustrates the lower sidewall and bead portion of a second embodiment of a runflat tire according to the invention, taken along a meridian plane through the axis of rotation;

Figure 3 illustrates the lower sidewall and bead portion of a third embodiment of a runflat tire according to the invention, taken along a meridian plane through the axis of rotation;

Figure 4 illustrates the lower sidewall and bead portion of a fourth embodiment of a runflat tire according to the invention, taken along a meridian plane through the axis of rotation.

Figure 5 illustrates the sidewall and bead portion of a fifth embodiment of a runflat tire according to the invention, taken along a meridian plane through th axis of

rotation, and having three carcasses layers in the sidewall and two in the bead; and

Figure 6 is an enlarged perspective view of the bead portion of a runflat tire corresponding to the fifth embodiment of the invention showing the common circumferential disposition of the first and second carcass layers.

DETAILED DESCRIPTION OF THE INVENTION

"Axial" and "axially" mean the lines or directions that are parallel to the axis of rotation of the tire.

"Radial" and "radially" mean directions radially toward or away the axis of rotation of the tire.

"Angle defined with respect to an axial direction" means an angle measured axially and radially outwardly from the innerside of the tire; such an angle is between 0 and 180 degrees.

As illustrated in figure 1, the tire of the invention comprises a bead 1 provided with a seat 13, specially adapted to fit on the tire's mounting rim. The bead extends substantially radially to the sidewall 15. The remaining portion of the sidewall and the tire summit are well known and thus not illustrated.

The tire comprises a carcass structure 10, extending from bead to bead or leaving a gap between two half structures, for instance in the substantially median portion of the summit. The radially inwardmost extent of the carcass structure 10 terminates in an anchoring zone 4 of the bead 1. Advantageously, the carcass structure is not turned up around bead cores or other bead reinforcement. That is to say, each axial coordinate defining the profile of the carcass structure has a unique radial position for each radial position less than that of the tire equator. The carcass structure is anchored in the bead portion by a bead reinforcement. A preferred embodiment of such a r inforc ment compris s a cord arrangement 11

provided with at least one substantially circumferentially oriented cord 12 laterally bordering the carcass structure on at least one side. In this instance "anchored" in the bead portion means that the arrangement resists the tension developed in the carcass structure during inflated or deflated use of the tire by the adherence of the carcass reinforcing structure laterally with the cords 12 rather than being wound around a traditional bead core.

The mechanical properties of the anchoring zone 4 are optimized in using a elastomeric bead filler having a very high elastic modulus. For instance, typical values may be within the following range: the shore A hardness may be equal or greater than 95 and the modulus at 10 % greater than 60 MPa.

Other examples of carcass anchorings or dispositions of the carcass layers in the bead portion have been disclosed in US 5,660,656 to Herbelleau et al and are incorporated herein by reference.

The bead 1 further comprises a heel portion 3 provided with elastomeric filler having a modulus of elasticity substantially lower than the anchoring zone 4 elastomeric filler modulus. A Shore A hardness between 55 and 65 is advantageously provided with a 10% modulus of 2 to 6 MPa.

The heel portion 3 is disposed in the bottom portion of the outer corner of the bead. The illustrated example is L-shaped, extending in the bottom portion towards the anchoring zone 4 and in the upper portion towards the sidewall 15, forming a wing 5. The bottom portion may extend up to a position substantially adjacent to the median reference profile 20 of the bead, or even further if necessary. The wing 5 is enclosed between the substantially central or interior bead portion 6, disposed radially internally, and an outer layer of elastomeric material forming the bead side 14. This bead side is intended to be in contact with the flange of the tire's design rim. The wing 5 of the heel portion 3 may extend radially for instance up to the radially outermost portion of the bead mounting side layer 14 or even further if necessary. The outer layer 14 is advantageously provided with a material being tear resistant and having a substantially high

modulus, that is to say a Shore A hardness between 65 and 75 and a modulus at 10 % between 6 and 10 MPa. In the embodiments presented here, the layer 14 envelops the whole of the bead sides in order to protect it during the various mounting and dismounting operations.

The heel portion 3 can have other forms, for instance, it can have a shape similar to a boomerang.

The inner bottom corner portion of the bead provides a toe portion 2, advantageously made with an elastomeric filler having a modulus of elasticity substantially the same or higher than the anchoring zone elastomeric filler modulus. In the illustrated example, the toe portion is substantially adjacent to the radially innermost portion of the anchoring zone 4.

The substantially central or interior bead portion 6 is advantageously provided with the same elastomeric filler as the anchoring zone 4, or with a material having similar characteristics. In a variant, it could also be provided with an elastomeric filler having a modulus at 10 % between 20 and 40 MPa.

As illustrated, the substantially central or interior bead portion 6 extends radially externally for instance up to a portion forming an interface between the bead and the sidewall. The axially inward portion of the radially outermost portion of the interior bead portion 6 constitutes a hard or resistant portion on which the carcass structure 10 can rest. This part 9 of the central part 6 of the bead can be considered as a carcass cooperating element, or support, or guide, adapted to cooperate with the adjacent portion of the carcass structure 10. To optimize the carcass cooperating element efficiency, at the interface between the cooperating element and the carcass structure, the profile is advantageously convex. Such a configuration creates a specific path of the carcass structure 10 which is substantially aligned with the bead general profile in the anchoring zone 4 and with a slight curved profile towards the outer portion of the tire in the radially outer portion of the bead. Above or radially externally with respect to the carcass cooperating element 9, the carcass structure profile may be slightly curved in the

opposite direction, to continue its path in the elastomeric bead filler 7 of the sidewall 15 according to a path substantially corresponding to the general path of the sidewall, but with the structure 10 advantageously disposed in the axially outer portion of the sidewall with respect to the median reference profile 20.

Of course, the curve profiles as well as their axial and radial positions may vary in accordance with the type of tire, its architecture and the desired characteristics.

The runflat tire of the invention may comprise one or several runflat inserts placed between the carcass structure 10 and the inner side of the tire. The sidewall innerside may comprise an airtight innerliner 8.

The low modulus heel portion 3 of the bead provides two advantages. First, it reduces the seat popping pressure, that is the tire cavity pressure utilized to place the beads of the tire upon their seats on the rim during the mounting operation. This pressure can be under, for instance, 40 psi. A second advantage of this part 3 is to act as a decoupling zone during deflated operation with cornering forces. In such a case, the tire sidewall is strongly bent and the bead is also bent around the upper rim flange. This flange acts as a leverage point, which tends to separate the seat 13 of the bead 1 from the seat of the rim. The soft heel portion 3 limits this separation and cooperates with the hard toe portion to keep in place the bead on the seat of the rim. This provides better performances in deflated operation of the tire.

As shown in figures 2 and 3, showing different embodiments, the tire may further comprises a second bead reinforcement 21, axially outwardly spaced apart from said first bead reinforcement. This second bead reinforcement 21 includes at least one substantially circumferentially oriented cord 22, having either a substantially generally radial path as illustrated in figure 2, or a substantially generally inclined profile, as illustrated in figure 3. In figure 2, the second bead reinforcement is disposed substantially axially, along the outer portion of the bead portion 6, bordering the wing 5. In figure 3, the second bead reinforcement is disposed transversally, extending from the radially and axially inward portion of the

anchoring zone 4 towards the radially outward portion of the wing 5. Such an arrangement may provide easier mounting characteristics. This second bead reinforcement increases the torsional and bending stiffness of the bead, this improves the performance of the tire in deflated operation conditions.

The cords 12 and 22 are advantageously made of steel. Monofilament or cable structure cords may be used. Textiles type cords, such as aramid, nylon, PET, PEN, or hybrids such as aramid/nylon, etc., may also be used alone or in combination with metallic cords. Figure 2 illustrates an example whereas the different zones A, B and C comprise different types of cords. For instance, zone A and C have steel type cords and zone B has textile type cords.

Figure 4 illustrates an embodiment of the tire of the invention in which the bead reinforcement and the anchoring zone define an angle α between 110 to 140 degrees with respect to an axial direction, the tire being in a similar position as when mounted on its design mounting rim and inflated at a nominal pressure. Accordingly, the carcass structure 10 path is, radially outward from the anchoring zone, completely in the outer side of the bead and of the sidewall.

Figure 5 illustrates a fifth embodiment of the invention in which the carcass structure 10 has more than one carcass layer within some portion of the tire. The carcass structure 10 comprises one circumferential alignment of cords in the summit 30. In the sidewall portion 15 of the tire, the carcass structure 10 is divided in three circumferential alignments of radial cords 511, 512 and 52. These three circumferential alignments of cords progressively move axially away from each other. In the bead 1, the two circumferential alignments of cords 511 and 512 join and give a common circumferential alignment of cords 51. Accordingly, in the bead 1, there are two circumferential alignments of cords 51 and 52.

This carcass structure is very flexible and allows placing the carcass cords where they are most useful. For instance, the density of cords of carcass layer 52 is superior to the carcass density of cords of the carcass layers 511 and 512. The cords of the outer carcass layer are subjected to high-tension stress-strain cycles

in inflated and deflated operation. These cords are well designed to support these high-tension cycles and the number of cords is defined accordingly. The cords of the inner carcass layer are subjected in deflated operation to stress-strain cycles with compression. In this case, it is the rubber mixes, which are well designed to support these compression stresses. The number of cords needs not to be high. It allows also a limited thickness of the carcass structure in the summit and an appropriate anchoring in the bead portion. The anchoring of the carcass structure 10 is achieved by three windings 41, 42, 43 of circumferential oriented cords, which axially border the two circumferential alignments of cords 51 and 52 of the carcass structure with the interposition of a high modulus rubber layer.

Advantageously, runflat inserts are placed in the sidewall between the carcass layers 511-512 - insert 92 - and 512-52 – insert 93 -, and also between the carcass structure 10 and the inner side of the tire – insert 91 - in order to have a good 0-psi performance. Preferably, these runflat inserts are in direct contact of the cords of the adjacent carcass layers. This means that the rubber mixes constituting the runflat inserts are in intimate contact with at least part of the outer circumference of the cord, and that during the building of the tire, no usual cushion rubber mix of low modulus of elasticity has been used. Accordingly, the sidewall structure has a better durability in deflated operation.

Figure 6 illustrates the structure of the radial and circumferential cords in the bead 1 of the fifth embodiment. In the anchoring zone, axially outward, we have the first circumferentially oriented winding 41, the first carcass circumferential alignment 51, the second circumferentially oriented winding 42, the second carcass circumferential alignment 52 and the third circumferentially oriented winding 43. Radially outwardly from the anchoring zone, the first carcass circumferential alignment 51 is divided in two carcass circumferential alignments 511 and 512. The rubber mixes are not represented in this figure for clarity. All these cords are embedded, at least in the anchoring zone, by a high modulus rubber mix. Preferably, this rubber mix has a shore A hardness over 80 and preferably over 95.

All the carcass cords presented in figure 6 are placed with a circumferentially shifted position, which allows them to form one sole alignment in the summit portion of the tire. This allows minimizing the thickness of the summit portion.

Within the scope of the invention, the carcass structure can also present one circumferential alignment of cords in the summit and the bead, which divide in two or three in the sidewall.

In order to position the reinforcement cords as precisely as possible, it is very advantageous to build the tire on a rigid support, for instance a rigid core imposing the shape of its inner cavity. All the components of the tire, which are disposed directly in their final place, are applied onto this core in the order required by the final architecture, without undergoing shaping at any moment of the building. In this case, the tire can be molded and vulcanized in the manner explained in US 4,895,692.

While the invention has been described in combination with embodiments thereof, it is evident that many alternatives, modifications, and variations will be apparent to those skilled in the art in light of the foregoing teachings. Accordingly, the invention is intended to embrace all such alternatives, modifications and variations as fall within the spirit and scope of the appended claims.

CLAIMS

1. A tire comprising at least one carcass structure anchored in each side of the tire in a bead, each bead having a base which is intended to be mounted on the tire's design mounting rim, each bead being extended radially upward by a sidewall portion, a reinforced summit, the sidewall portions joining said summit, wherein said bead further comprises an anchoring zone for anchoring said carcass structure in said bead and a heel portion provided with elastomeric filler having a modulus of elasticity substantially lower than the anchoring zone elastomeric filler modulus.

2. A tire according to claim 1, wherein said heel portion is disposed in the axially substantially outermost portion of the bead.

3. A tire according to claim 1 or 2, wherein said heel portion is disposed in the radially substantially innermost portion of the bead.

4. A tire according to any one of preceding claims, wherein said heel portion extends axially inward.

5. A tire according to claim 4, wherein said heel portion extends inward up to a position substantially adjacent to the median reference profile of the bead.

6. A tire according to any one of preceding claims, wherein at least a section of said heel portion extends substantially radially.

7. A tire according to claim 6, wherein said section extends substantially radially up to the radially outermost portion of the mounting surface side of the bead.

8. A tire according to any one of preceding claims, wherein said bead further comprises a toe portion provided with elastomeric filler having a modulus of elasticity substantially the same or higher than the anchoring zone elastomeric filler modulus.

9. A tire according to claim 8, wherein said toe portion is disposed axially and radially inward with respect to the anchoring zone.

10. A tire according to any one of preceding claims, wherein the bead further comprises a carcass cooperating element provided radially outward of the bead and axially outward of the carcass structure.

11. A tire according to claim 10, wherein said carcass cooperating element is provided with a substantially curvilinear profile adapted to cooperate with the carcass structure from the top of the anchoring zone towards a radially and axially outermost zone of the sidewall.

12. A tire according to any one of preceding claims, being adapted for continued mobility in a substantially deflated condition.

13. A tire according to any one of preceding claims, wherein said carcass structure comprises at least one circumferential alignment of cords in the anchoring zone of the bead which progressively divides in the sidewall portion in at least two circumferential alignments of cords.

14. A tire according to claim 13, wherein a runflat insert is disposed between said two carcass circumferential cord alignments and wherein said runflat insert is in direct contact with the cords of said two circumferential alignments.

15. A tire according to claim 13 or 14, wherein said carcass structure comprises only one circumferential alignment in the summit portion of the tire.

16. A tire comprising at least one carcass structure anchored in each side of the tire in a bead, each bead having a base which is intended to be mounted on the tire's design mounting rim, each bead being extended radially upward by a sidewall portion, a reinforced summit, the sidewall portions joining said summit, said bead further comprises an anchoring zone for anchoring said carcass in

said bead and a heel portion provided with elastomeric filler having a modulus of elasticity substantially lower than the anchoring zone elastomeric filler modulus, wherein said anchoring zone is provided with at least one first bead reinforcement, axially bordering said carcass structure, for anchoring said at least one carcass structure in the beads.

17. A tire according to claim 16, wherein said bead reinforcement includes substantially circumferentially oriented cords laterally bordering the carcass structure on at least one side and adapted to take up the tension developed in the carcass.

18. A tire according to claim 16 or 17, further comprising a second bead reinforcement, axially spaced apart from said first bead reinforcement.

19. A tire according to claim 18, wherein said second bead reinforcement includes substantially circumferentially oriented cords.

20. A tire according to any one of claims 16 to 19, The tire of claim 16, being adapted for continued mobility in a substantially deflated condition.

21. A tire according to any one of claims 16 to 20, The tire of claim 16, wherein said carcass structure comprises at least one circumferential alignment of cords in the anchoring zone of the bead which progressively divides in the sidewall portion in at least two circumferential alignments of cords.

22. A tire according to claim 21, wherein a runflat insert is disposed between said two carcass circumferential cord alignments and wherein said runflat insert is in direct contact with the cords of said two circumferential alignments.

23. A tire according to claim 22, wherein said carcass structure comprises only one circumferential alignment in the summit portion of the tire.

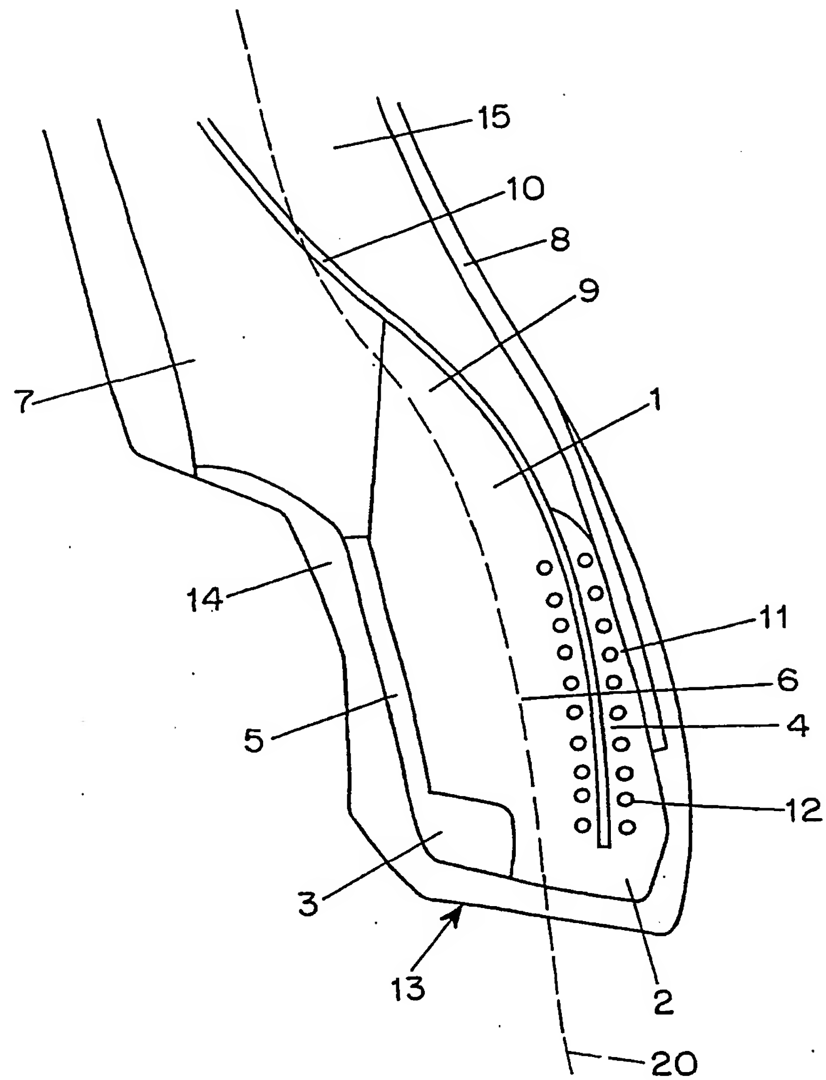

FIG. 1

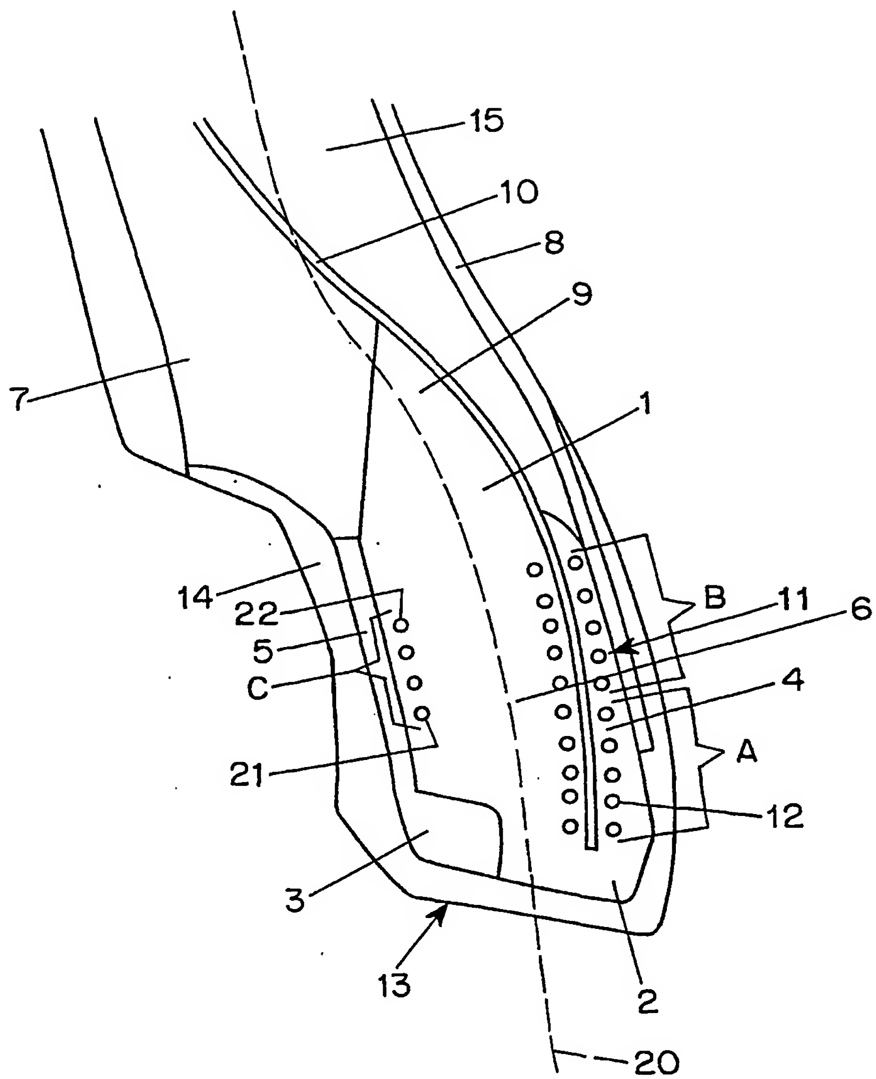

FIG. 2

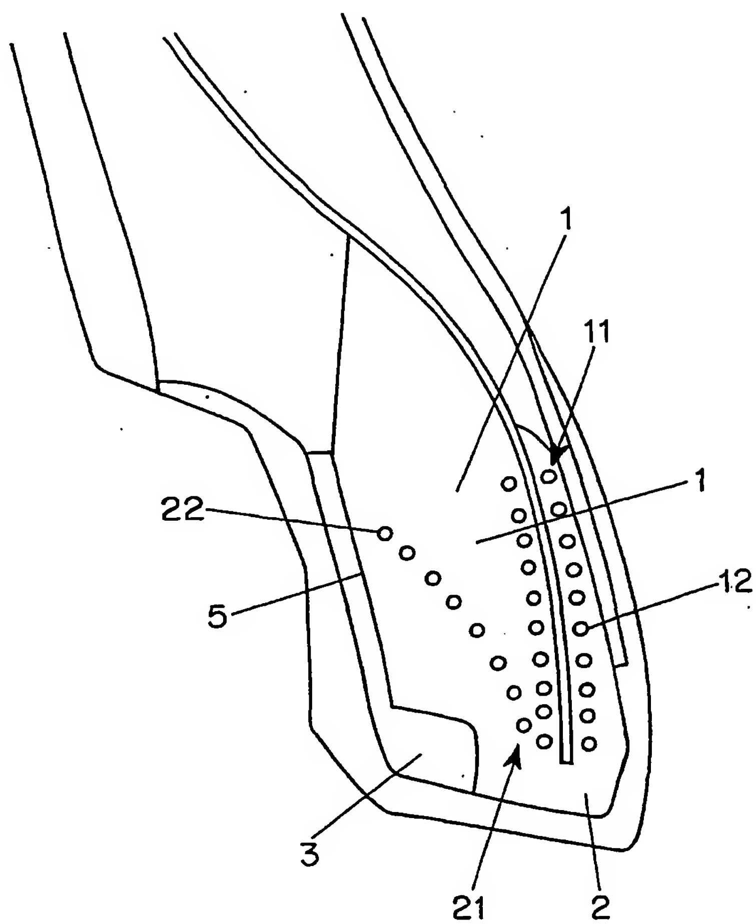

FIG. 3

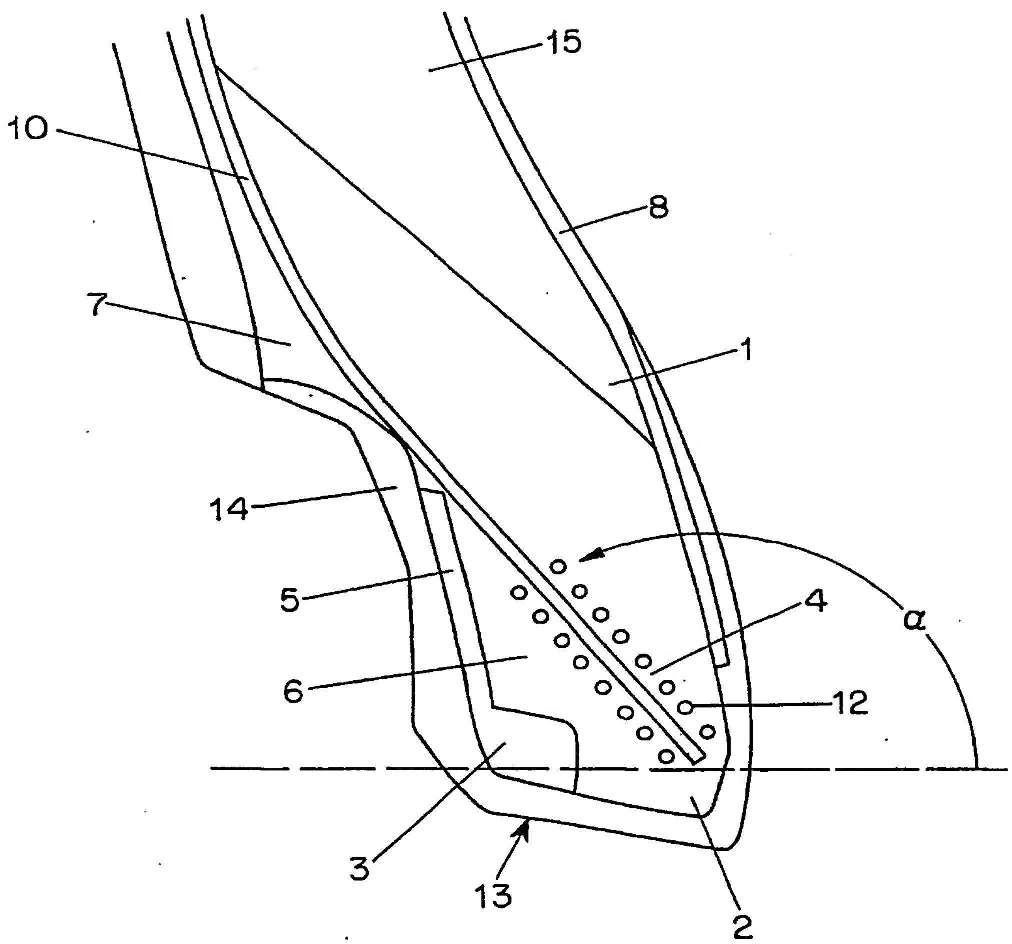

FIG. 4

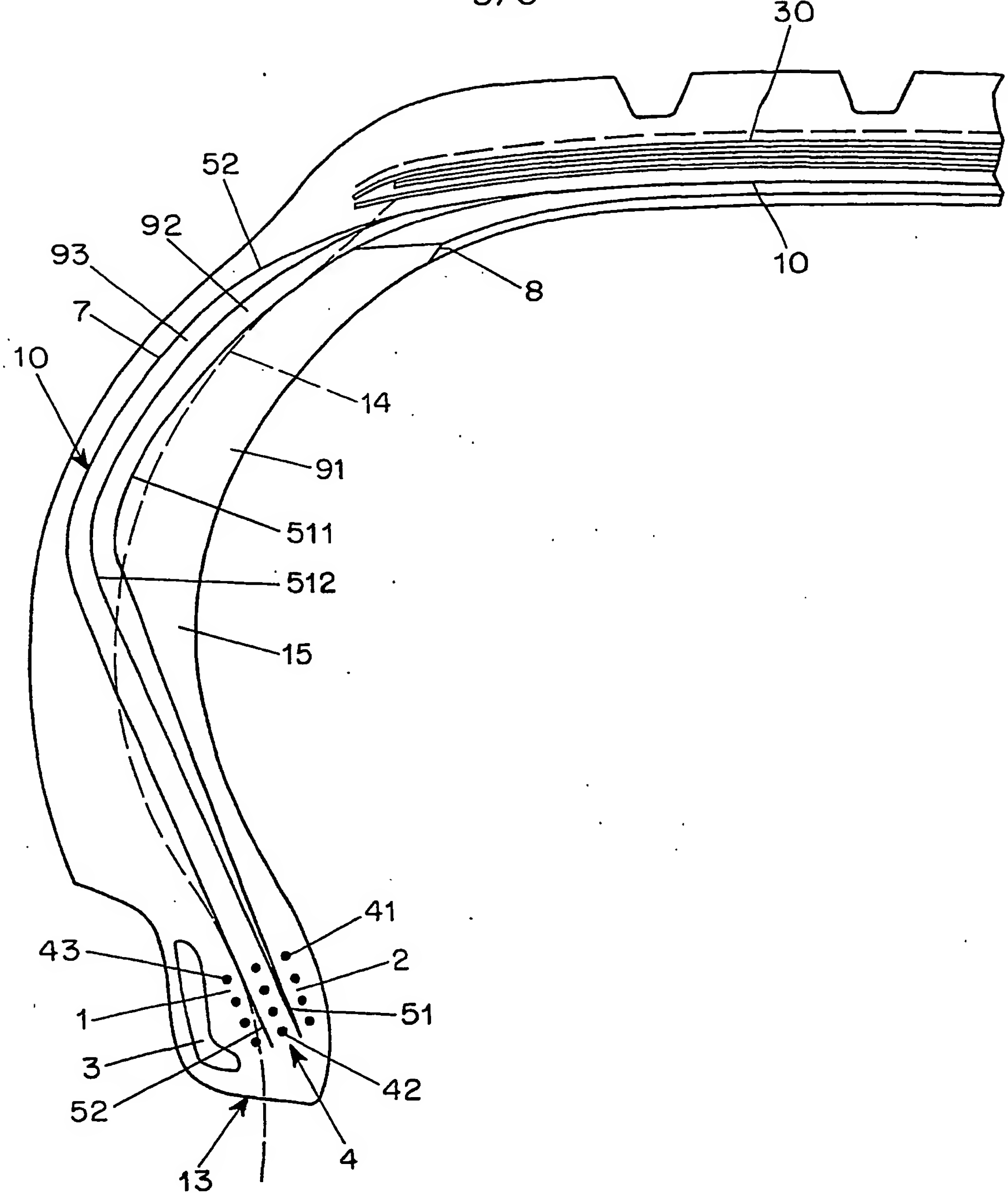

FIG. 5

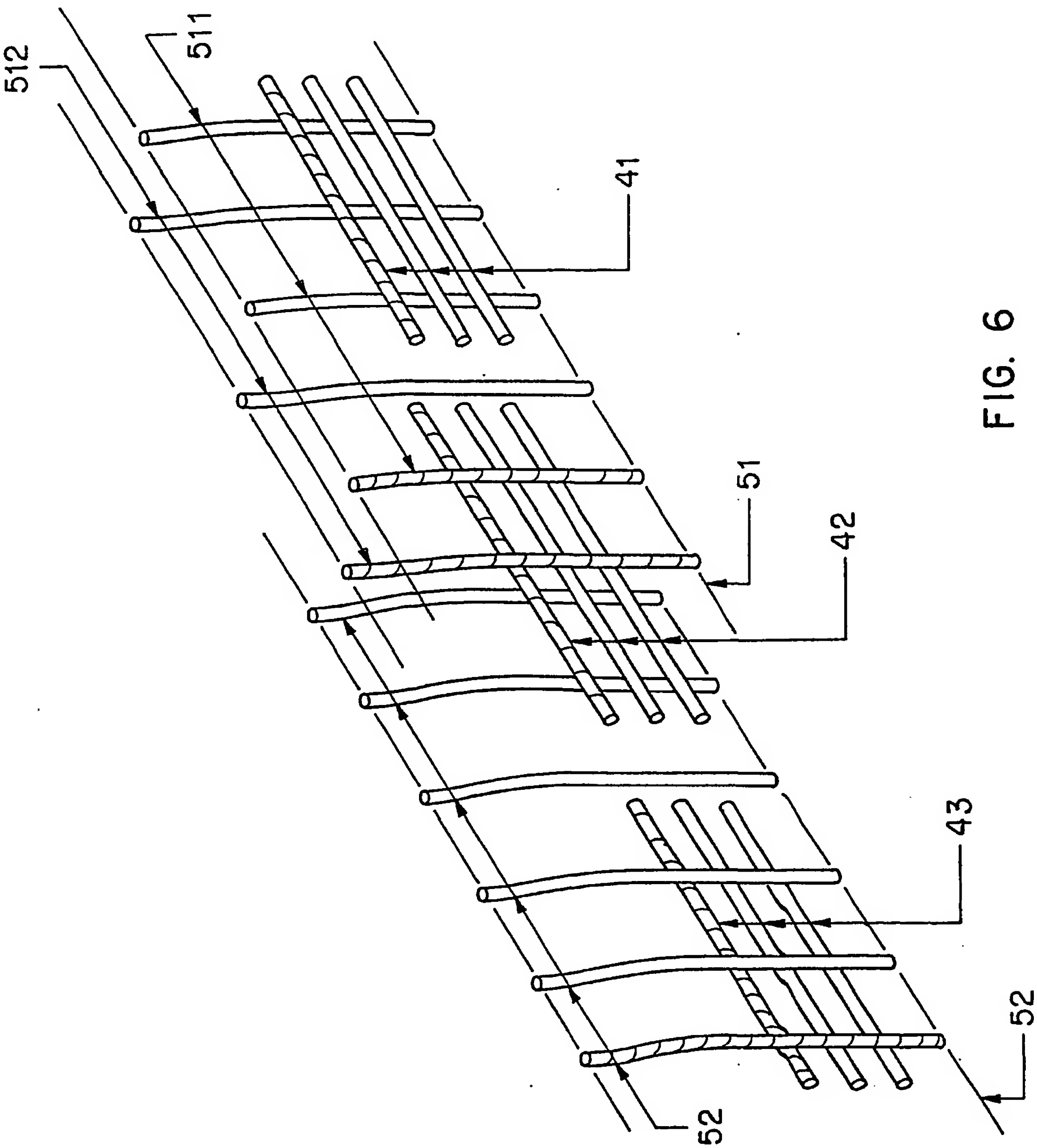

FIG. 6

INTERNATIONAL SEARCH REPORT

Inten d Application No
PCT/EP 01/11568

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B60C15/06 B60C15/00 B60C17/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B60C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 869 017 A (MICHELIN & CIE) 7 October 1998 (1998-10-07) column 6, line 16 -column 7, line 25 figure 3 ---	1-4,6,7, 10,11, 16-19
A	PATENT ABSTRACTS OF JAPAN vol. 003, no. 112 (M-073), 18 September 1979 (1979-09-18) -& JP 54 088501 A (BRIDGESTONE CORP), 13 July 1979 (1979-07-13) abstract figure 4 ---	1,5,8,9
A	EP 0 376 172 A (YOKOHAMA RUBBER CO LTD) 4 July 1990 (1990-07-04) abstract figure 2 ---	1,8,9

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search	Date of mailing of the international search report
27 February 2002	07/03/2002

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INTERNATIONAL SEARCH REPORT

Inter Application No
PCT/EP 01/11568

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 511 599 A (WILLARD JR WALTER L) 30 April 1996 (1996-04-30) the whole document	1-15
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INTERNATIONAL SEARCH REPORT

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